REMARKS

Claims 1-5 and 17-20 have been amended herein to clarify the inventive aspects of the present invention. Support for the proposed amendments can be found in claim 1 as filed, in the abstract, and in the description, page 2, line 32 to page 3, line 17, page 4, lines 30-32, and page 51, line 31 to page 52, line 3. Applicant has addressed every ground for rejection in the Office Action dated April 15, 2008, and believes the application is now in condition for allowance. Accordingly, reconsideration of this application is respectfully requested.

I. The amended claims are definite and fully supported by the application.

In addition to the arguments set forth below, Applicant herewith submits the following comments in response to the Examiner's Response to Arguments set forth in Sections 6A and B of the Office Action. While Applicant believes that the term "transparent" is fully supported by the specification and understood by one of ordinary skill in the art, without admission, Applicant has removed the term "transparent" from claims 1 and 17.

With respect to the Examiner's objection of the terms 'mostly elastic' and 'cloudy', it is respectfully submitted that the degree of elastic scattering is sufficiently defined to be understood by one of ordinary skill in the art – i.e., such that it provides a rate of progressive decrease in neutron energy that enhances neutron capture efficiency by resonance neutron capture.

In response to the Examiner's objection of claim 1 as being broader than the enabling disclosure, it is respectfully submitted that Claim 1 specifies that activation region includes lead and/or bismuth, materials identified in the specification. Thus, the objection relating to claim 1 being broader than the enabling disclosure does not stand.

With respect to the Examiner's objection to the claim language of an inner and outer buffer region, the term "inner buffer region" in claim 1 has been replaced by the

term "first buffer region" and the term "outer buffer region" in claim 5 has been replaced by the term "second buffer region"

II. Bowman does not disclose an activation region as claimed.

In addition to the arguments set forth below, Applicant herewith submits the following comments in response to the Examiner's Response to Arguments set forth in Section 6C of the Office Action to demonstrate that Bowman does not disclose an activation region according to amended claims 1 and 17.

The molten salt recirculation loop and blanket as shown in Bowman cannot be considered to be the activation region according to revised claims 1 and 17 since it is not made of lead or bismuth and does not enable a slow decrease of neutron energy by elastic scattering to enhance neutron capture by resonant neutron capture.

Molten salt does not exhibit the properties that lead to a progressive decrease of neutron energy by elastic scattering that enables resonance capture to be exploited. As explained on page 3, lines 31 to 33, of the present application, lead and bismuth have the properties of an anomalously small neutron capture cross-section and very small lethargy (fractional average energy loss at each neutron elastic collision).

Lead and bismuth have a small neutron capture cross section compared to its neutron elastic scattering cross section. In the case of lead, the neutron scattering cross section is approximately 11 barns while the neutron absorption cross section is 0.0048 barns. In the case of bismuth, the neutron scattering cross section is approximately 9 barns while the neutron absorption cross section is 0.034 barns. This enables a high proportion of elastic scattering. Both lead and bismuth or a mixture thereof have a lethargy to the order of $9.54\ 10^{-3}$. There is no disclosure in Bowman of the molten salt having these properties which lead to the progressive loss of neutron energy.

In Bowman, the fission products within the molten blanket are higher actinide waste products and thus have significant neutron capture probabilities and cross sections

at high neutron energy. Consequently, the medium is dominated by *inelastic* scattering events, and neutron energy does not need to be progressively decreased.

It is important to note that in Bowman there is no incentive to reduce neutron energy according to the claimed invention since high energy neutrons are required to burn the high actinide products in the molten salt medium after having passed through the container holding the fission fragments. The concept of the invention of Bowman is to eliminate two types of waste using the same beam – higher actinide waste along with fission fragments. Firstly by passing the neutron flux through container 98 containing the fission fragments with small neutron cross sections, and then through the blanket containing the high actinide products, which must be burned with high energy neutrons.

Consequently, the skilled person would have no incentive to seek a solution to slowly decrease neutron energy and enhance neutron capture according to the amended claims. In view of the above, it is respectfully submitted that Bowman does not read on the inventive concept as defined in amended claims 1 and 17.

III. In view of the cancellation of Claim 49, the double patenting rejection is traversed and should be withdrawn.

As set forth above, Claim 49 is cancelled. Accordingly, the rejection of Claim 49 as being a substantial duplicate of Claim 1 is traversed and should be withdrawn.

IV. Claims 1, 2, 4-6, 8, 9, 12, 17, 19-22, 24, 25, 28, 31-32, and 49 do not claim the same invention as that of claims 1-33 of prior U.S. Patent No. 5,774,514.

The invention as defined in revised claims 1 and 17 differs from the invention of U.S. Patent No. 5,774,514 (the US'514 patent) in a number of ways as set out below:

The US'514 patent is not concerned with enhancing neutron capture efficiency. In fact, the US'514 patent explicitly aims to minimize neutron flux to prevent nuclear capture (column 2, lines 50 to 59). This is to minimize neutron capture by β-precursors instead of the desired decay into useful fissile elements. It is further stated in col. 7, lines 20-21 of the US'514 patent, that the energy amplifier must operate at relatively low

neutron flux to ensure correct performance. In contrast, the invention as defined in the revised claims explicitly sets out to enhance neutron flux and neutron capture in the material in the activation region.

The diversifying functions of the invention of the US'514 patent and the invention as claimed in the present application are clearly illustrated on page 7, line 33 to page 8, line 9, of the present application where the energy amplifier of the US'514 patent is described as playing the role of the neutron source of the present invention.

Moreover, the US'514 patent fails to disclose an arrangement in which the method steps of the present invention would be inherent. the US'514 patent does not describe providing an activation region made of heavy elements including lead and/or bismuth. The examiner considers main core region 128 illustrated in Figure 21 to be the activation region since it contains the fuel. However, main core region 128 is not made of lead. Although the Examiner argues that molten lead circulates through the main core, the molten lead does not form part of region 128. Instead, the document describes molten lead, acting as a coolant, passing through zone 123 which is separate to and exterior to core 121 which incorporates zones 128. Moreover, zone 123 cannot be considered to constitute the activation region of the present invention since it does not have a distribution of radioactive waste material within it. Indeed, this would be contrary to safety since the lead circulates through an external heat exchanger. Any collisions with lead in region 123 would not result in an enhanced neutron flux and slow decrease of neutron energy in activation region 128, nor an increased neutron capture by resonance neutron capture in material in the activation region as required by new claims 1 and 17. Accordingly, it is respectfully submitted that the double patenting rejection of the claims in view of the US '514 patent is traversed and should be withdrawn.

V. The specification provides an adequate written description of the invention.

The specification stands rejected under 35 U.S.C. 112, first paragraph, on the basis that there is no adequate description nor enabling disclosure of the impurities in the diffusing medium. In furtherance of prior arguments addressing the "impurities" that the

Examiner addressed, it is reiterated that the impurities refer to the material or isotopes to be activated and not the general content of the diffusing medium. As attested to by Yacine Kadi, this disclosure is easily understood by one skilled in the art that has read the entire specification and has the structure of the activator 16 in mind. [Kadi declaration, par. 5]. This is apparent from the specification including from, but not limited to, the following passages:

- "If a small amount of impurity to be activated is added to the transparent medium, it will capture some neutrons." Page 32, lines 10-11.
- "In such a region [i.e., the Activation Region] . . . are embedded the samples to be activated, for instance, inside narrow, thin tubes." Page 53, lines 1-5.
- ". . . transmutation rates are largely independent of the chemical binding and isotopic composition of the materials inserted in the Activator." Page 56, lines 13-15.
- "Therefore, one can imagine thin, sealed stainless tubes, similar to fuel pins except that they contain ^{99}Tc in dispersed form of metal wires or equivalent geometry and Iodine vapours at low pressure." Page 81, lines 2-5.

[Kadi declaration, par. 5]

As previously set forth, the present invention is directed to a transmuter that places a material in an activation region so that the material intentionally captures the neutrons and changes into a different species (e.g., a desired isotope). [See Kadi declaration, par. 6]. Accordingly, as expressly set forth in the specification, it is the materials or isotopes that are distributed or embedded within the diffusing medium that captures the neutrons, and not the diffusing medium. [Id.].

The specification also stands objected to under 35 U.S.C. 112, first paragraph on the basis that the Examiner believed it fails to provide an adequate written description of the invention. The written description requirement requires a determination of "whether the description clearly allows persons of ordinary skill in the art to recognize that he or she invented what is claimed" (In re Gosteli, 872 F.2d 1008, 1012, 10 USPQ2d 1614, 1618 (Fed. Cir. 1989), MPEP 2163.02). The enablement requirement requires a

determination of whether the disclosure when filed "contained sufficient information regarding the subject matter of the claims as to enable one skilled in the pertinent art to make and use the claimed invention" (See Mineral Separation v. Hyde, 242 U.S. 261, 270 (1916), MPEP 2164.01). As with the written description requirement, the Examiner is required to determine how one skilled in the art would interpret and understand the specification and claims.

The phrase that "the diffusing medium is transparent to neutrons" has been removed from Claims 1 and 17. It is respectfully submitted that, for the reasons set forth herein and in prior arguments, the specification provides a written description of what is claimed to permit one skilled in the art to know what Applicant is claiming as its invention and how to practice it. Accordingly, it is respectfully submitted that this rejection is traversed and should be withdrawn.

VI. The claims are supported by the specification.

The pending claims stand rejected under 35 USC 112, first paragraph, on the basis that the terms "diffusing medium" and "transparent" are not adequately supported in the specification. As set forth above, the claims have been amended to remove the terms "diffusing medium" and "transparent". Accordingly, it is respectfully submitted that this rejection is traversed and should be withdrawn.

VII. The claims are definite.

Claims 1, 2, 4-6, 8, 9, 12, 17, 19-22, 24, 25, 28, 31-32 and 49 stand rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. As set forth above, the term "inner buffer region" has been replaced by the term "first buffer region" in claims 1 and 17; the term "outer buffer region" has been replaced by the term "second buffer region" in claims 5 and 20; and the term "transparent" has been removed

from claims 1 and 17. Accordingly, it is respectfully submitted that the claims are definite and this rejection is traversed and should be withdrawn.

VIII. The claims are not anticipated by Bowman.

Claims 1, 2, 4-6, 8, 9, 12, 17, 19-20, 24, 25, 28 and 49 stand rejected under 35 U.S.C. 102(b) as being anticipated by Bowman (5,160,696). For the reasons set forth below, among others, it is respectfully submitted that Bowman does not disclose, among other things, an activation region according to amended claims 1 and 17.

The lead-bismuth target enclosure 84 of Figure 4 of Bowman cannot be considered to be the activation region, since:

(1) it does not have a distribution of material to be exposed within in it, and

(2) scattering within this region will be inelastic due to the high energy of the neutrons, similarly to the function of the first buffer region of the present application. Thus, there is no inherent disclosure of multiple elastic collisions within this region resulting in an enhanced neutron flux and a slow decrease of neutron energy leading to resonant neutron capture in a distributed material.

Containment means 98 cannot be considered to be the activation region since it is not made of lead and does not provide multiple elastic collisions to enhance neutron flux and neutron capture. In fact, Bowman provides its own alternative solution for increasing neutron flux in the container medium – by placing the container close to the target – column 11, lines 34 to 37. An intense neutron source is required to compensate for the low cross section of minor actinides.

Furthermore, containment means 98 is not arranged around the source. As outlined in the present application on page 53, lines 1 to 22 of the present application, it is important that the radioactive waste sample is distributed around the source to make use of the whole flux and to avoid self screening.

Moderator 40 cannot be considered to be the activation region since it uses heavy water instead of lead, and does not have a distribution of radioactive waste. In such a

medium, neutrons will undergo inelastic scattering similarly to the buffer or moderator of the present invention. Further, it is not placed around the source.

Molten salt recirculation loop and blanket cannot be considered to be the activation region according to revised claims 1 and 17 since it is not made of lead and does not lead to a slow decrease of neutron energy by elastic scattering to enhance neutron capture. The fission products within the molten blanket have significant neutron capture probabilities and cross section at high neutron energy, thus the medium is dominated by *inelastic* scattering events, and neutron energy does not need to be progressively decreased.

There is no disclosure of the molten salt medium having the properties of small neutron capture cross section and low lethargy that would enable it to progressively decrease neutron energy such that resonant neutron capture may be exploited.

It is important to note that in Bowman there would be no incentive to reduce neutron energy according to the claimed invention since high energy neutrons are required to burn the high actinide products in the molten salt medium after having passed through the container holding the fission fragments. The concept of the invention of Bowman is to eliminate two types of waste using the same beam – higher actinide waste along with fission fragments. Firstly by passing the neutron flux through container 98 containing the fission fragments with small neutron cross sections, and then through the blanket containing the high actinide products which must be burned with high energy neutrons.

Consequently, the skilled person would have no incentive to seek a solution to slowly decrease neutron energy in order to enhance neutron capture.

Moreover, as previously mentioned, Bowman provides its own alternative solution for increasing neutron flux in the container medium – by placing the container close to the target – column 11, lines 34 to 37. An intense neutron source is required to compensate for the low cross section of minor actinides.

Thus, if the skilled person on reading Bowman wished to increase neutron flux in a medium container fission fragments, he would position the medium closer to the neutron source and use a high power neutron source.

On the basis of the above, it is respectfully submitted that amended claims 1 and 17 are both novel and non-obvious with respect to Bowman.

IX. The claims are not anticipated by Venneri et al.

Claims 1, 17 and 49 stand rejected under 35 U.S.C. 102(a) as being anticipated by U.S. 6,442,226 to Venneri et al. (Venneri). The Examiner argues that region 22 of the embodiment of Figure 9 of Venneri performs the function of a buffer region and an activation region. He goes on to say that lead target 22 of Figure 9 will act and behave in the same manner as activation region of the present invention.

Claim 49 has been cancelled. For the reasons set forth below, among others, it is respectfully submitted that Venneri fails to disclose each of the method steps defined in revised claims 1 and 17.

Venneri does not disclose multiple elastic scattering of neutrons and a slow decrease in neutron energy in zone 22 which enhances neutron flux and neutron capture efficiency. In fact, Venneri explicitly states in col. 5, line 33, that there is no attempt to moderate neutrons in the fast neutron spectrum system based on liquid lead and that fast neutrons are supplied for utilization in a uranium enrichment blanket surrounding the system at the expense of radioactive waste in the burn apparatus. Thus, Venneri does not explicitly or inherently disclose a slow decrease in neutron energy as required by claims 1 and 17.

It is submitted that region 22 of the arrangement shown in Figure 9 would <u>not</u> perform the function of the activation region as defined in claims 1 and 17. In fact, the arrangement of Figure 9 would suffer from the problem outlined on page 42, lines 8 to 13 of the present application, namely that if the materials to be transmuted were directly inserted into the core, the transmutation rate would be lower. This is because the neutron

flux would be concentrated at energies in which the captures by the long-lived FF's have a very small cross-section.

The Thorium fluoride blanket 34 of Figure 9 is not made of lead and thus does not constitute the activation region according to claims 1 and 17.

In the embodiment shown in Figure 1 of Venneri, the molten salt multiplying assembly is not made of lead and does not result in the claimed neutron activity, and so does not constitute an activation region in the context of the present invention as defined in claims 1 and 17. There is no disclosure of molten salt multiplying assembly exhibiting the properties of lead and bismuth (small neutron capture compared to elastic scattering cross section and small lethargy – see arguments in Section II above).

Moreover, it is submitted that the document does not inherently disclose a rate of progressive decrease in energy by elastic collisions such that neutron capture is enhanced by resonance neutron capture. If the neutrons lost energy as defined in claims 1 and 17, there would be few high energy neutrons reaching the surrounding breeding blanket and the system would not operate effectively.

Consequently, revised claims 1 and 17 fulfil the requirements of novelty with respect to Venneri et al.

Venneri is concerned with a different problem to the problem addressed by revised claims 1 and 17. Venneri deals with plutonium and higher actinides (see column 10, lines 59 to 60) which are fissionable under fast neutrons. (see page 7, lines 8 to 13 of the present application). Since fast neutrons are required, there is no incentive or motivation to progressively reduce the energy of neutrons as required in claims 1 and 17.

Venneri also does not seek to enhance neutron capture by resonance neutron capture as required by claims 1 and 17 since it seeks to provide a large number of neutrons for breeding in the surrounding enrichment blanket (see col. 3, lines 25-27).

The skilled person would have no incentive or motivation to change the arrangement of Venneri to the method of claims 1 and 17 since neutron capture should be minimized before neutrons reach the thorium blankets, and high neutron energy is

required to burn higher actinides. In fact, Venneri teaches against the solution defined in claims 1 and 17.

Consequently, revised claims 1 and 17 fulfil the requirements of both novelty and non-obviousness with respect to Venneri et al.

X. Claims 21-22 are not obvious over the prior art.

Claims 21-22 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Bowman ('696) as applied to claims 1, 2, 4-6, 8, 9, 12, 17, 19-20, 24, 25, 28 and 49 above and further in view of Borst (3,197,375). For the reasons set forth above with respect to Claim 17, it is respectfully submitted that Claims 21 and 22 are both novel and inventive.

XI. Claims 31-32 are not obvious over the prior art.

Claims 31-32 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Bowman (696) as applied to claims 1, 2, 4-6, 8, 9, 12, 17, 19-20, 24, 25, 28 and 49 above and further in view of Ruddock (4,123,497). For the reasons set forth above with respect to Claim 17, it is respectfully submitted that Claims 31 and 32 are both novel and inventive.

XII. Claims 1 and 17 are not obvious over the prior art.

Claims 1, 17 and 49 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. 5,160,696 to Bowman in view of U.S. 6,442,226 to Venneri.

Claim 49 has been cancelled. For the reasons set forth herewithin, it is respectfully submitted that Bowman does not disclose an activation region according to revised claims 1 and 17.

The lead-bismuth target enclosure 84 of Figure 4 cannot be considered to be the activation region, since:

(1) it does not have a distribution of radio-waste material within in it, and

(2) scattering within this region will be inelastic due to the high energy of the neutrons, similarly to the function of the buffer of the present application. Thus, there is no inherent disclosure of multiple elastic collisions within this region resulting in an enhanced neutron flux, a slow decrease of neutron energy and an enhanced neutron capture in the radioactive waste material.

Containment means 98 cannot be considered to be the activation region since it is not made of lead and does not provide multiple elastic collisions to enhance neutron flux and neutron capture. In fact, Bowman provides its own alternative solution for increasing neutron flux in the container medium – by placing the container close to the target – column 11, lines 34 to 37. An intense neutron source is required to compensate for the low cross section of minor actinides.

Furthermore, containment means 98 is not arranged around the source. As outlined in the present application on page 53, lines 1 to 22, it is important that the radioactive waste sample is distributed around the source to make use of the whole flux and to avoid self screening.

Moderator 40 cannot be considered to be the activation region since it uses heavy water instead of lead, and does not have a distribution of radioactive waste. In such a medium, neutrons will undergo inelastic scattering similarly to the buffer or moderator of the present invention. Further, it is not placed around the source.

Molten salt recirculation loop cannot be considered to be the activation region according to revised claim 49 since it is not made of lead and does not lead to a slow decrease of neutron energy by elastic scattering to enhance neutron capture. The fission products within the molten blanket have significant neutron capture probabilities and cross section at high neutron energy, thus the medium is dominated by *inelastic* scattering events, and neutron energy does not need to be progressively decreased.

It is important to note that in Bowman there is no incentive to reduce neutron energy according to the claimed invention since high energy neutrons are required to burn the high actinide products in the molten salt medium after having passed through the container holding the fission fragments. The concept of the invention of Bowman is to

eliminate two types of waste using the same beam – higher actinide waste along with fission fragments. Firstly by passing the neutron flux through container 98 containing the fission fragments with small neutron cross sections, and then through the blanket containing the high actinide products which must be burned with high energy neutrons.

Consequently, the skilled person would have no incentive to seek a solution to slowly decrease neutron energy and enhance neutron capture.

Moreover, as previously mentioned Bowman provides its own alternative solution for increasing neutron flux in the container medium – by placing the container close to the target – column 11, lines 34 to 37. An intense neutron source is required to compensate for the low cross section of minor actinides.

Thus, if the skilled person on reading Bowman wished to increase neutron flux in a medium container fission fragments, he would position the medium closer to the neutron source and use a high power neutron source.

Even if the skilled person were to combine the teachings of Venneri and Bowman, the combination of Venneri and Bowman will not lead to the claimed invention. There is no teaching in Venneri that would lead to the claimed invention. In fact, Vennneri teaches away from the claimed invention.

Venneri deals with the elimination of plutonium and higher actinides (see column 10, lines 59 to 60) which are fissionable under fast neutrons. (see page 7, lines 8 to 13), and does not teach towards the claimed invention for the elimination of fission fragments at lower neutron energies where neutron capture cross section is higher.

There is no teaching in Venneri, as outlined above, that would lead to an activation region in which multiple elastic collisions between neutrons and heavy elements result in enhanced neutron flux and slow decrease of neutron energy.

Even if radioactive material were placed in the target container of Bowman, the resulting arrangement would suffer from the problem outlined on page 42, lines 8 to 13 of the present application, namely that the transmutation rate would be lower. This is because the neutron flux would be concentrated at energies in which the captures by the long-lived FF's have a very small cross-section.

Venneri teaches towards providing high energy neutrons to burn higher actinides and minimizing neutron captures so that an effective number of high energy neutrons reach the external thorium blankets. It is thus submitted that Venneri teaches against the solution defined in revised claims 1 and 17.

Consequently, revised claims 1 and 17 are not obvious in view of Bowman and Venneri.

XIII. Claims 1, 17 and 49 are not obvious over Stanton in view of Venneri.

Claims 1, 17, 49 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. 3,349,001 to Stanton in view of U.S. 6,442,226 to Venneri. As set forth above, Claim 49 has been cancelled. For the reasons set forth herewithin, it is respectfully submitted that claims 1 and 17 are patentable over these references.

The Examiner considers the molten metal target region 20 in Figure 1 of Stanton to constitute an activation region in the context of the present invention. However, region 20 differs to the activation region defined in claims 1 and 17 in that:

(1) it does not have a distribution of material containing radioactive waste material; and

(2) it does not provide multiple elastic scattering leading to a progressive decrease in neutron energy and related enhanced neutron capture.

Even if material were to be inserted into the molten metal the resulting arrangement would suffer from the problem outlined on page 42, lines 8 to 13 of the present application, namely that the transmutation rate would be lower. This is because the neutron flux would be concentrated at energies in which the captures by the long-lived FF's have a very small cross-section.

As outlined in the previous sections, there is no teaching in Venneri which would lead to the activation region of the claimed invention.

Consequently, it is respectfully submitted that revised claims 1 and 17 are not obvious in view of a combination of Stanton and Venneri.

XIV. Conclusion.

None of the cited documents disclose or suggest, among other things, an activation region as defined in claims 1 and 17, nor the principle of transmutation based on adiabatic resonance which is the technical effect provided by the claimed method. Therefore, it is respectfully submitted that claims 1 and 17 meets the requirements of novelty and non-obviousness. The dependent claims are considered to be allowable by virtue of their dependency from claims 1 and 17. Accordingly, for these and other reasons, it is respectively requested that the claims should be allowed and proceed to issuance.

Should the Examiner discover that there are remaining issues that could be resolved by an interview, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

Dated: August 22, 2008

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